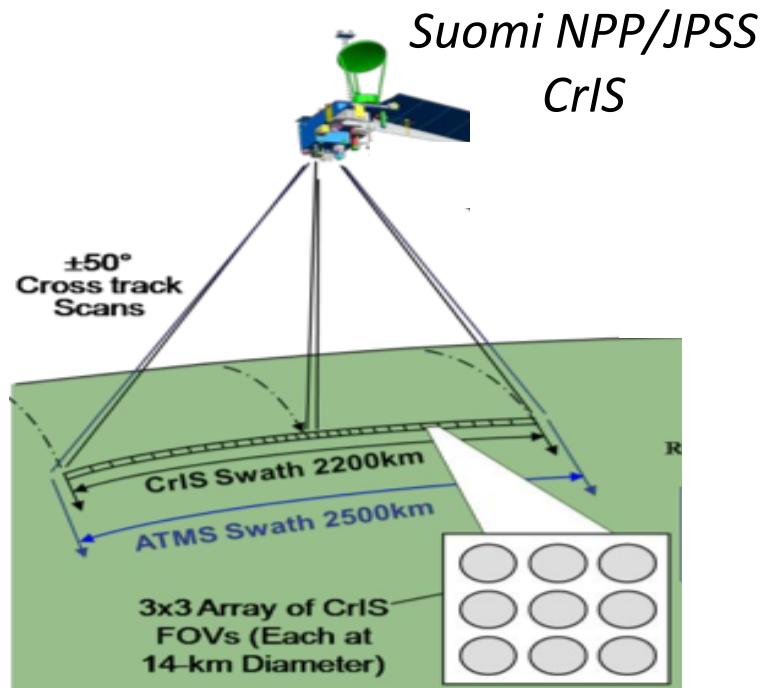
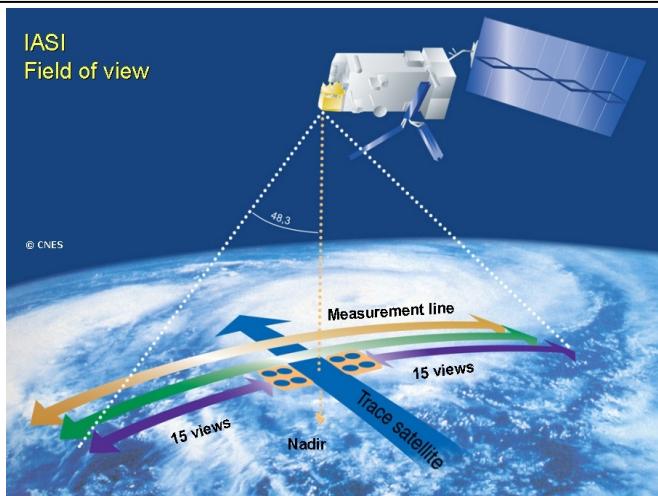
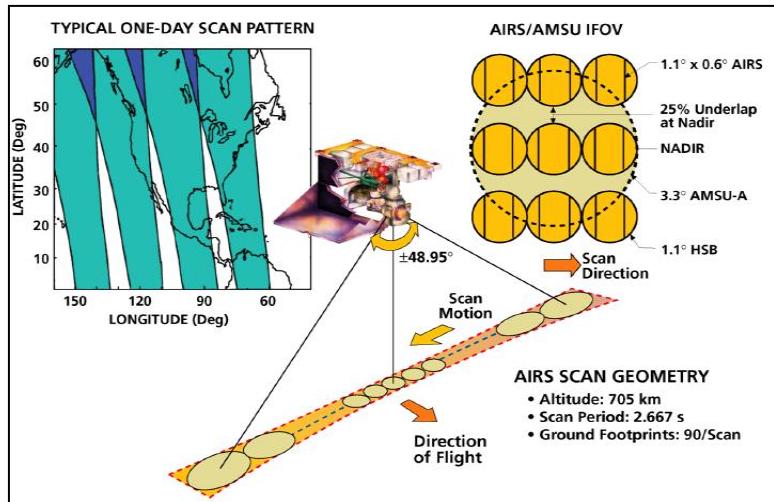
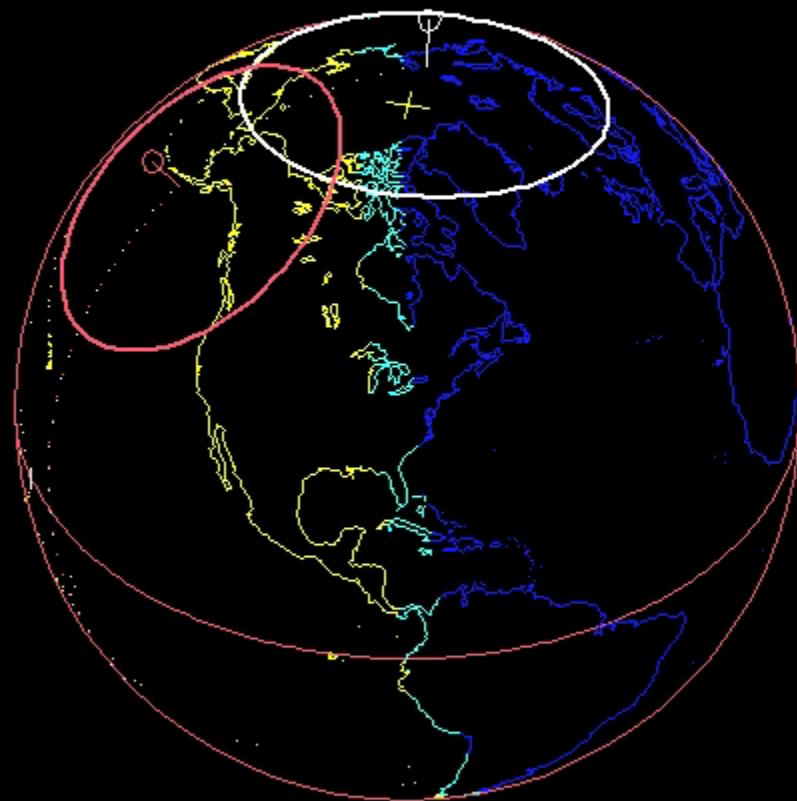


# *Comparison of AIRS and CrIS Radiances & Retrievals*

W. Smith, E. Weisz, D. Tobin, X. Liu, R. Knuteson, H. Revercomb, A. Larar, M. Goldberg



NPP	12062.8791	7202.18	98.71	101.44	824.18
AQUA	12061.3531	7077.72	98.22	98.83	699.72
METOPA	12060.6586	7195.64	98.71	101.30	817.64



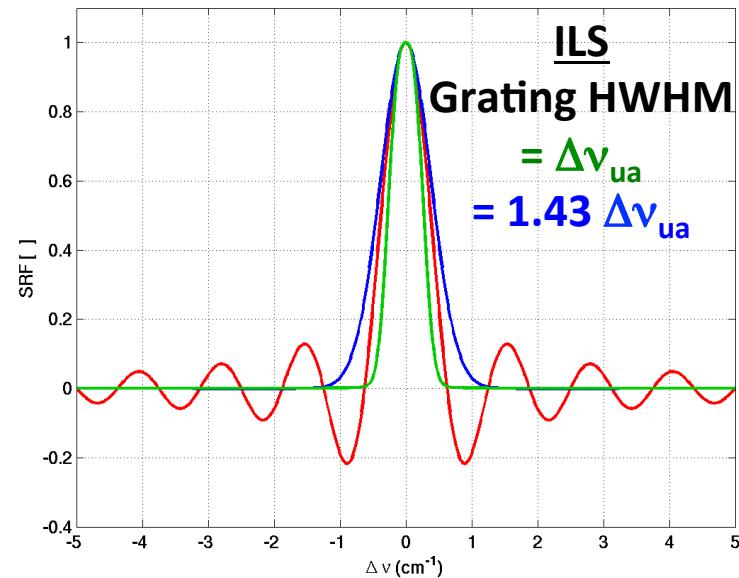
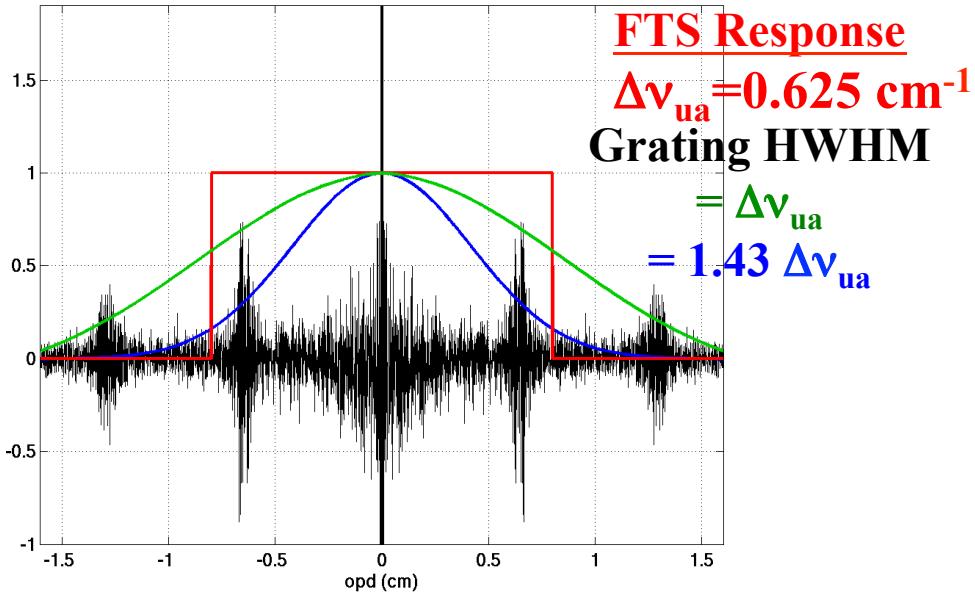
METEOROLOGICAL SATELLITES

23:33 UT 1 MAR 12



# Satellite Instrument Characteristics

Instrument	Spatial resolution	spectral res. ( $\text{cm}^{-1}$ )	spectral rng. ( $\text{cm}^{-1}$ )	spatial sampling
AIRS (2002 - )	14 - km	~1200 resolving power ( $0.5 - 2.5 \text{ cm}^{-1}$ )	650-2665	Contiguous Cross-track scan 90 FOVs
CrIS (2011 - )	14 - km	0.8 max OPD (full res) $0.625, 1.3, 2.6 \text{ cm}^{-1}$	650-2550	Contiguous Cross-track Scan 30 3x3FOV Arrays

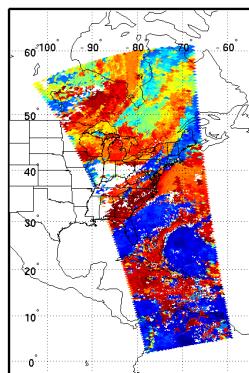


\* After: H. E. Revercomb: “High Resolution Workshop-GIFTS-HES” 26 Apr 2006

## *Simulation of AIRS From CrIS*

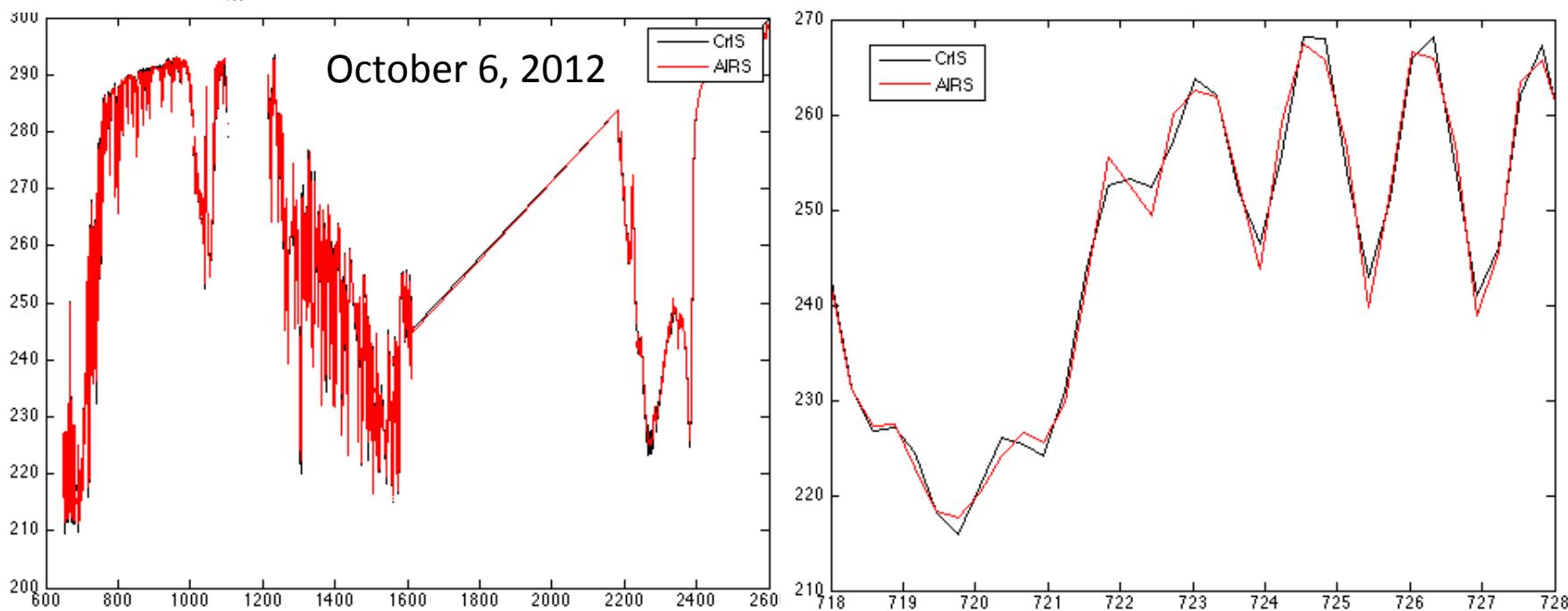
### *(Convolute Unapodized CrIS using AIRS SRFs )*

1. Use co-located clear sky samples of CrIS and AIRS retrievals and radiance spectra
2. Define “clear sample” as: psfc>950 hPa; difference between CrIS and AIRS window BT <2 K, AIRS window BT >270 K, difference between the secant (AIRS LZA) and the secant (CrIS LZA) < 0.2
3. Transform CrIS radiance spectra to AIRS radiance spectra by:
  - Zero expanding CrIS interferogram to a max OPD which is a factor of 1/40 x original (i.e.,  $\pm 32$  cm) and FFT the expanded IFGM to a fine scale spectrum ( $0.015 \text{ cm}^{-1}$ )
  - Convolute CrIS unapodized fine scale spectrum to AIRS spectral points using the AIRS Spectral Response Functions (SRFs)



# Spectral Resolution Comparison

Simulated AIRS from CrIS by applying AIRS SRFs directly to fine scale (i.e.,  $1/40 \times$  nominal spacing) observed CrIS radiance spectrum



*Example shows that the CrIS inherent spectral resolution is equal to or greater than that of the AIRS*

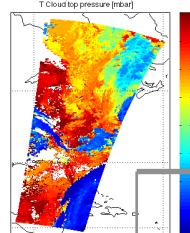
# *Simulation of AIRS From CrIS*

## *(Double Difference Method\*)*

1. Use co-located clear sky samples of CrIS and AIRS retrievals and radiance spectra
2. Defined “clear sample” as: Cloud Mask for both AIRS and CrIS are set to “Clear”; difference between CrIS and AIRS retrieved surface skin temperature <2 K, AIRS surface temperature >270 K, difference between the secant (AIRS LZA) and the secant (CrIS LZA) < 0.2
3. Transformed CrIS radiance spectra to AIRS radiance spectra by computing the observed minus PCRTM calculated CrIS radiance difference, performing a 40 times expanded scale (interferogram zero filled) interpolation and applying the AIRS SRFs to produce CrIS observed – calculated difference spectra on the AIRS spectral scale (Tobin et. al., 2007).
4. Produced CrIS simulated AIRS spectra by adding the results of (3) to the PCRTM calculated AIRS radiance spectrum

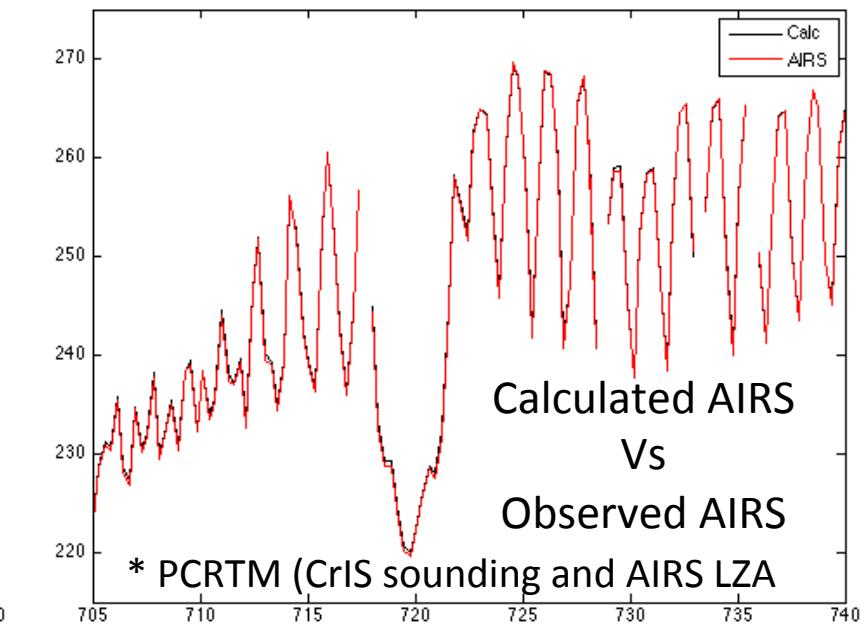
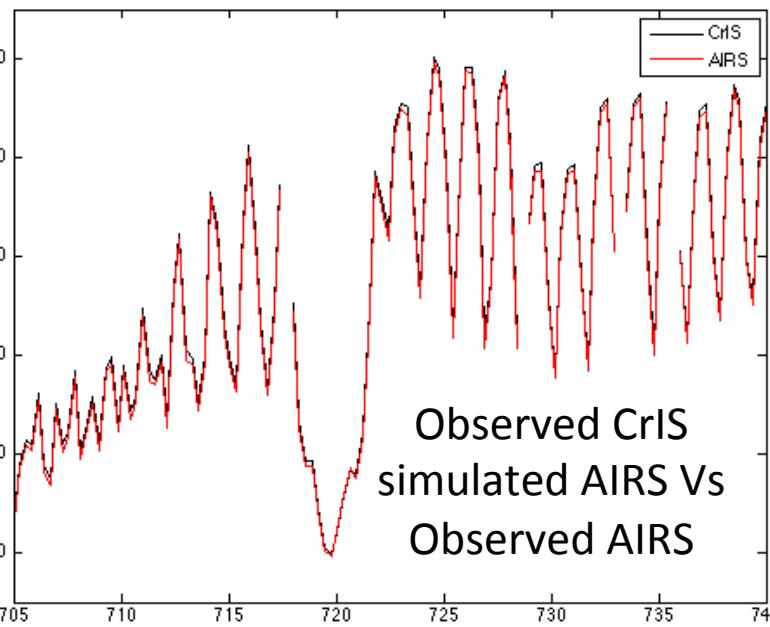
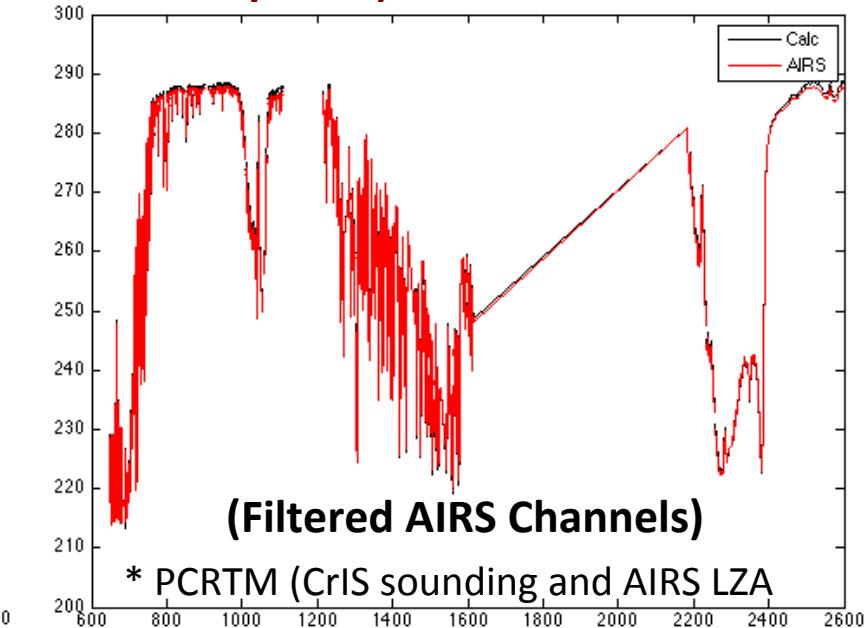
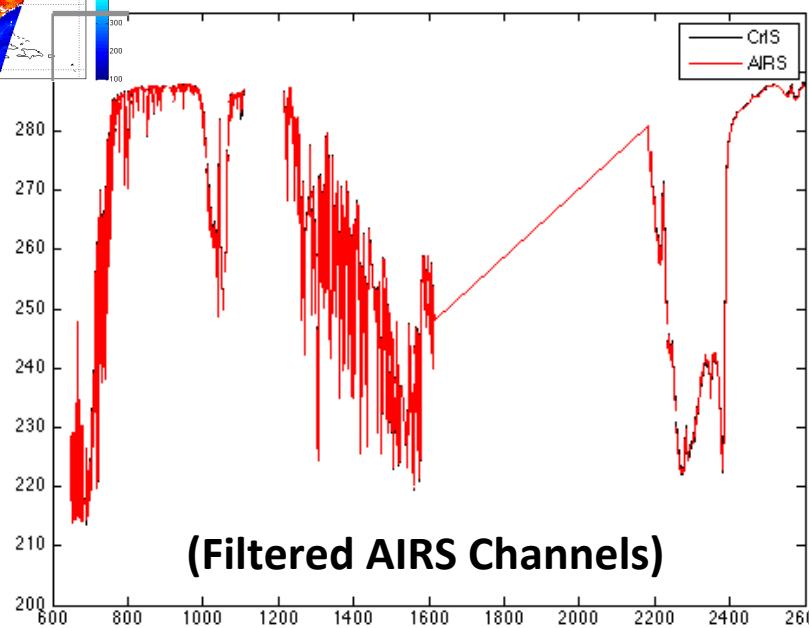
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\* Corrects for local zenith angle and residual spectral response differences



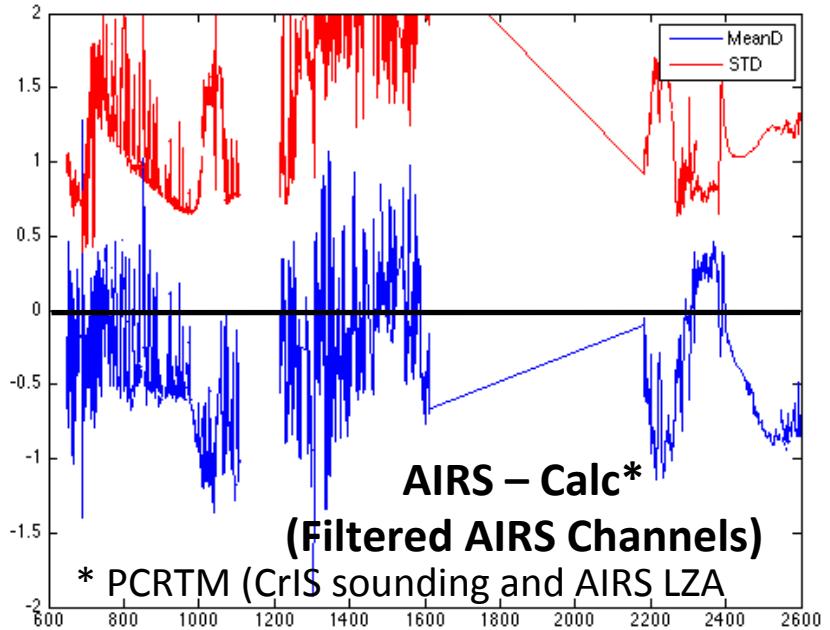
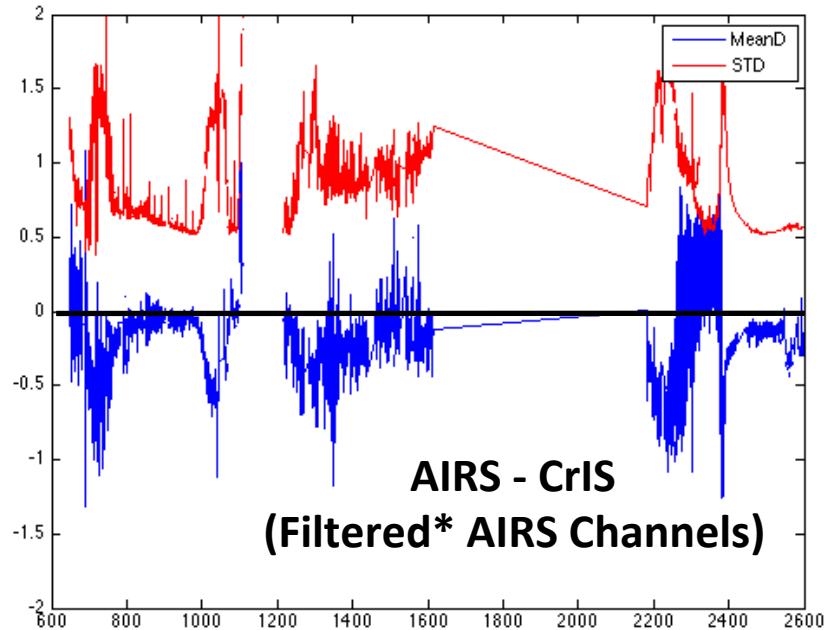
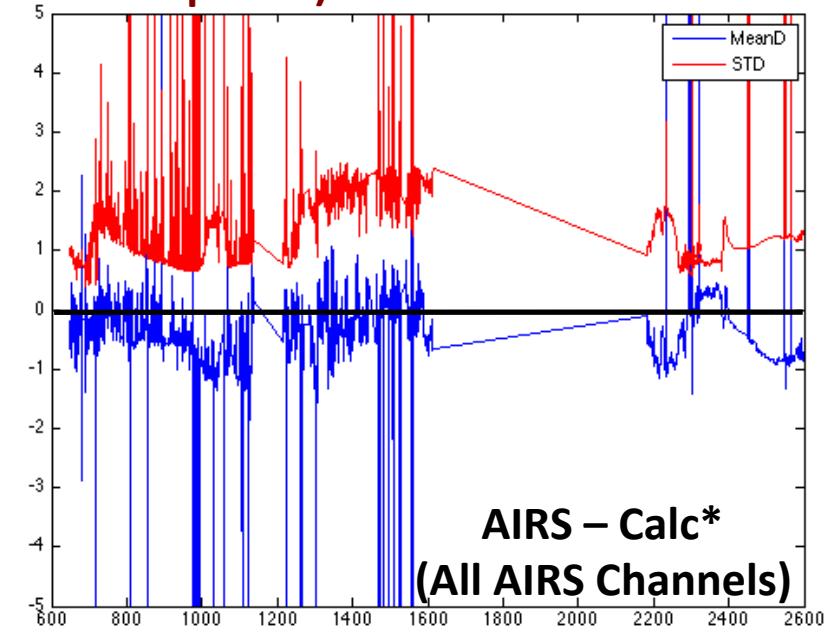
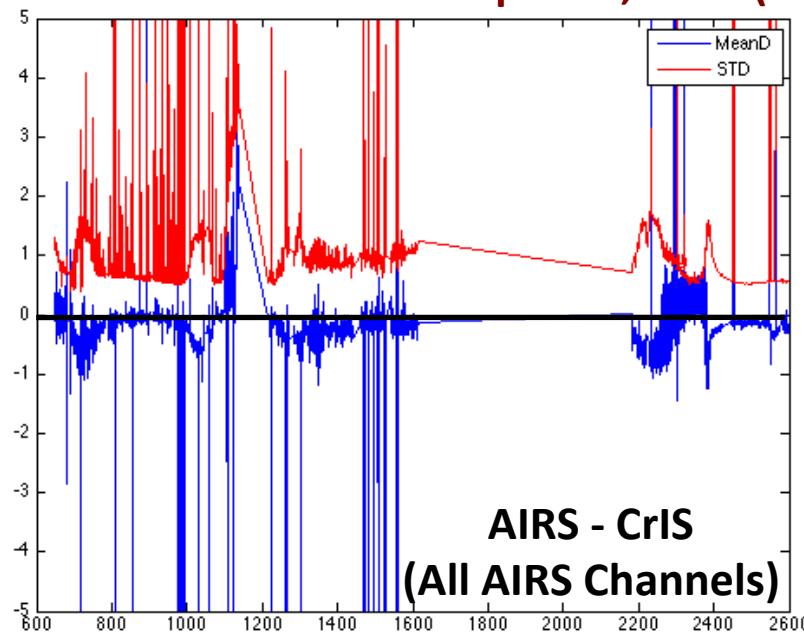
# Mean Brightness Temperature Spectra

April 27, 2012 (760 "Clear" Spectra)



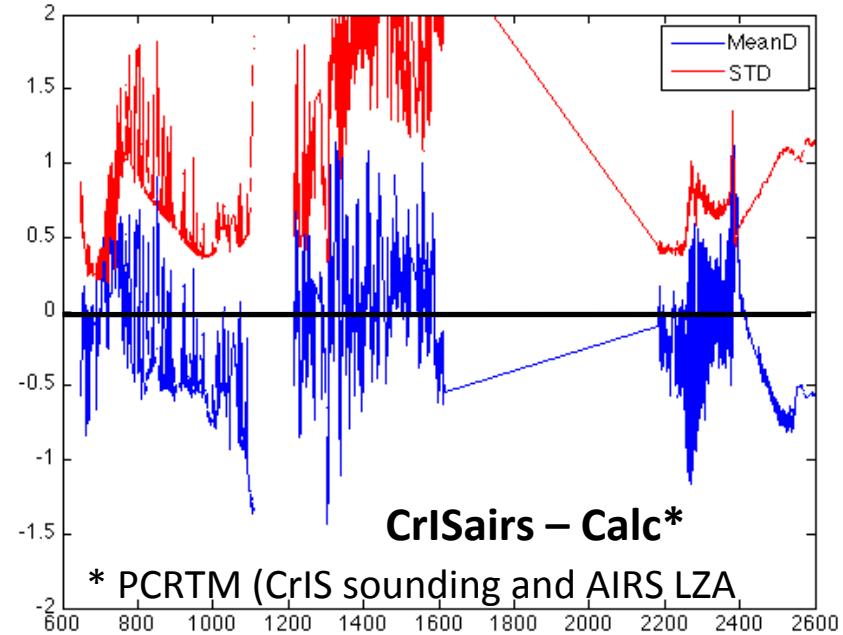
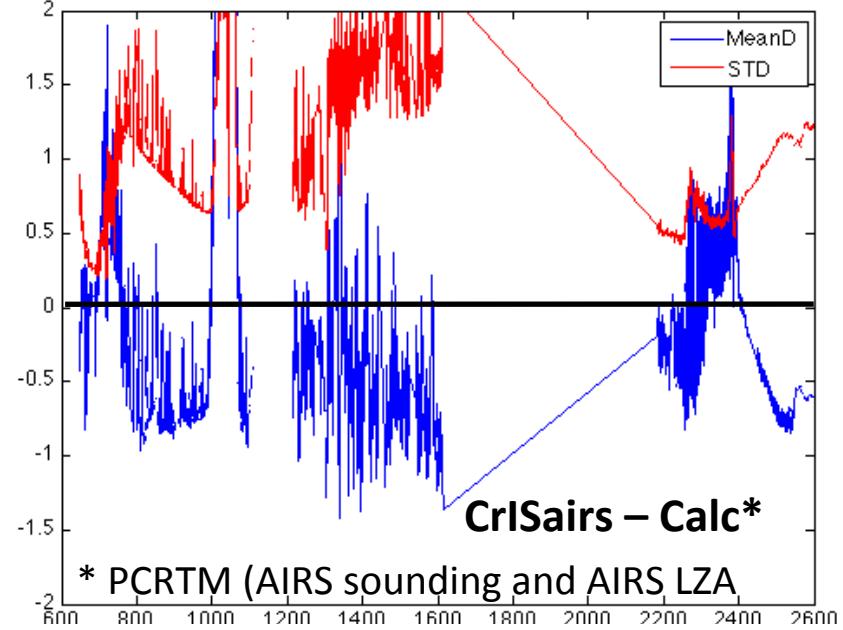
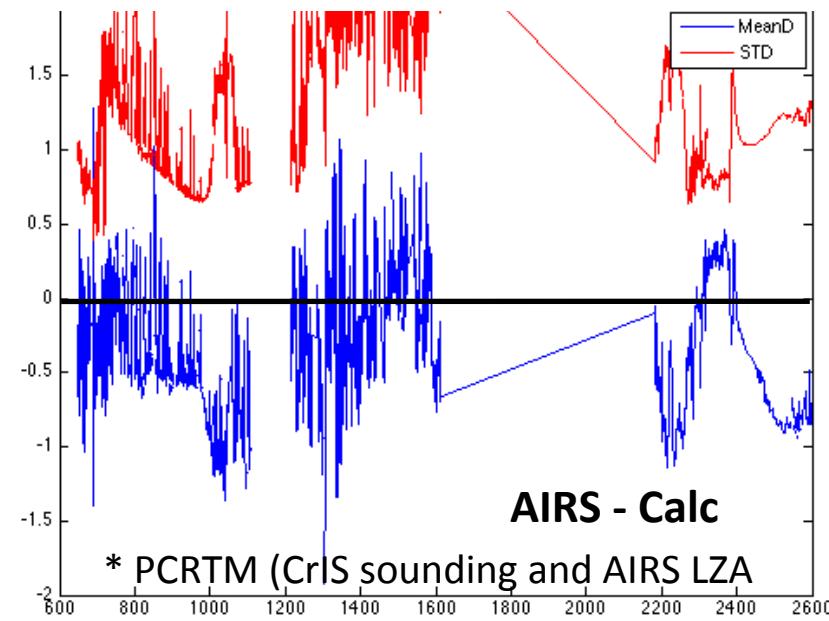
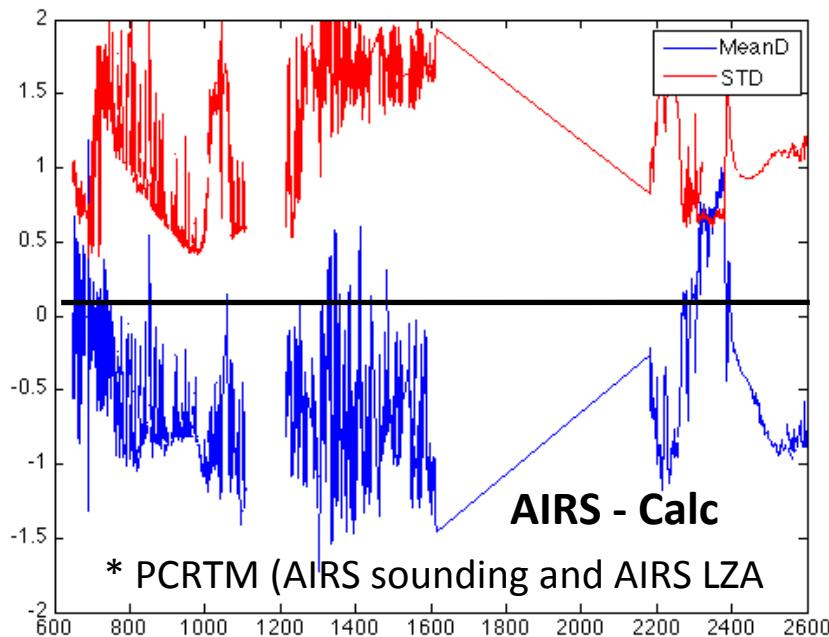
# *Mean and Standard Deviation Results*

April 27, 2012 (760 "Clear" Spectra)



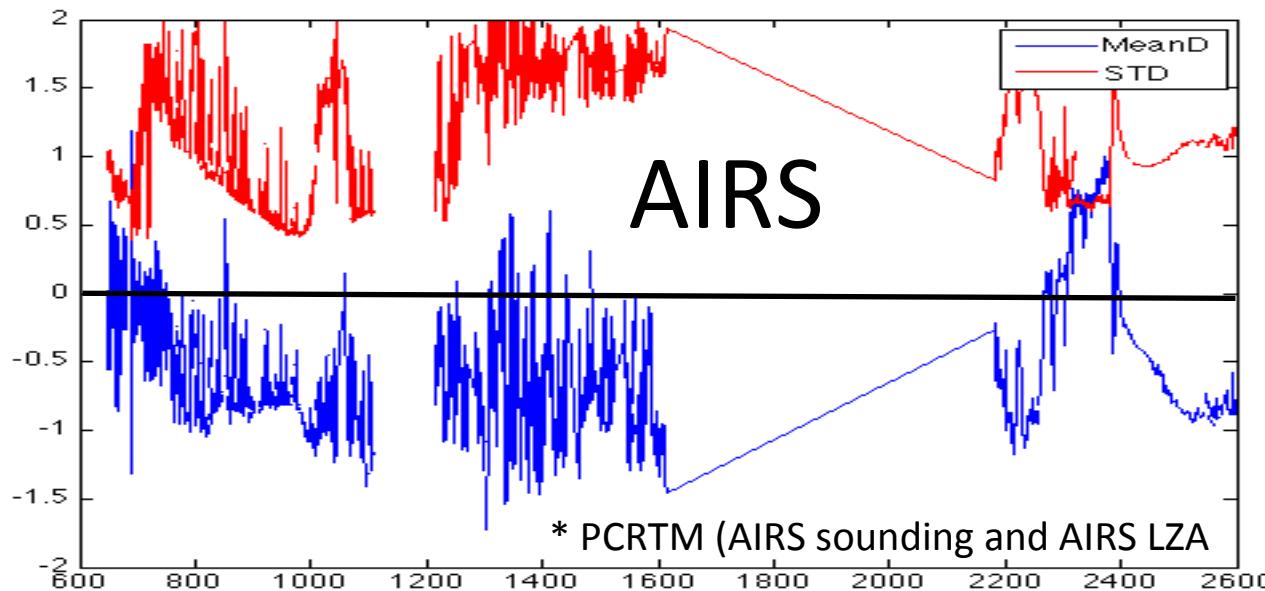
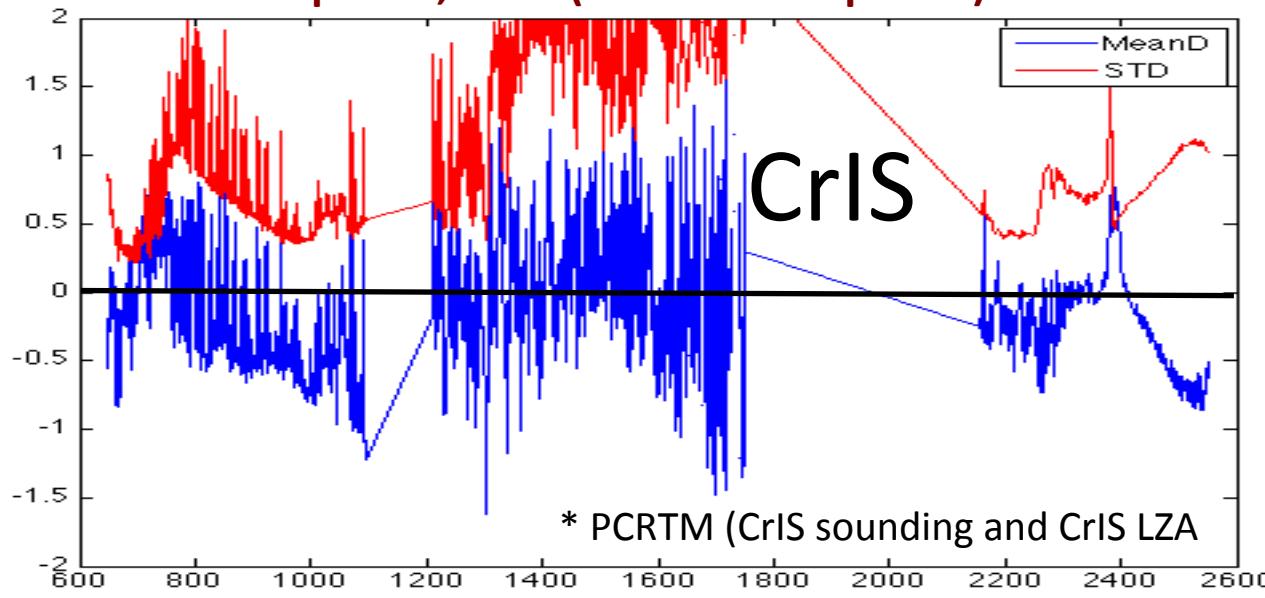
# *Mean and Standard Deviation Results*

April 27, 2012 (760 "Clear" Spectra)

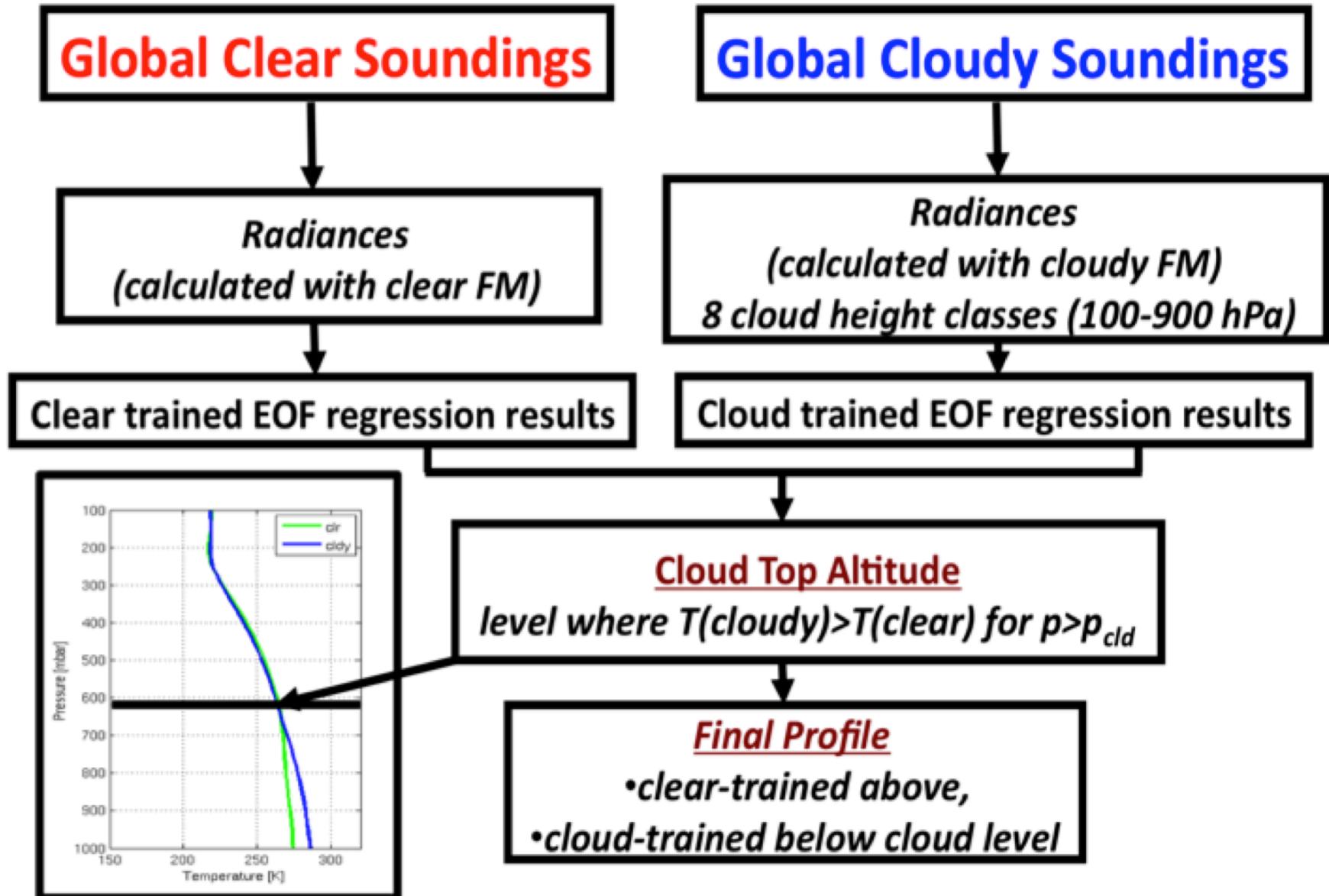


Observed minus Calc Bias & STD Results  
(each on their own spectral Scale)

April 27, 2012 (760 "Clear" Spectra)

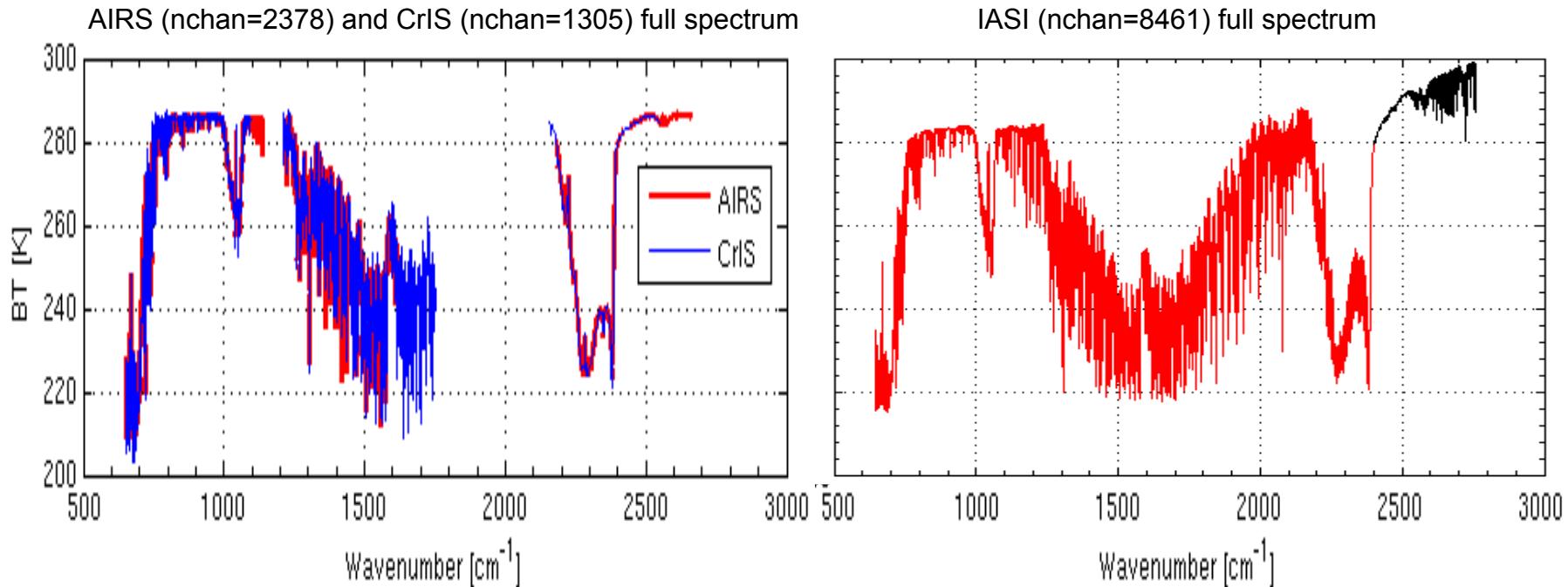


# *Direct Broadcast “Dual-Regression” Retrieval Algorithm\**



\* Smith, William L., Elisabeth Weisz, Stanislav V. Kireev, Daniel K. Zhou, Zhenglong Li, Eva E. Borbas, 2012: Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. *J. Appl. Meteor. Climatol.*, **51**, 1455–1476.

# AIRS, CrIS, and IASI Sounding Channels



- In the retrieval channels from  $665 \text{ cm}^{-1}$  to  $2400 \text{ cm}^{-1}$  are used.
  - AIRS = 1258 (30 PCs)
  - CrIS = 1245 (30 PCs)
  - IASI = 7021 (50 PCs)

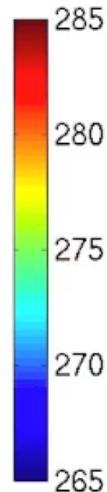
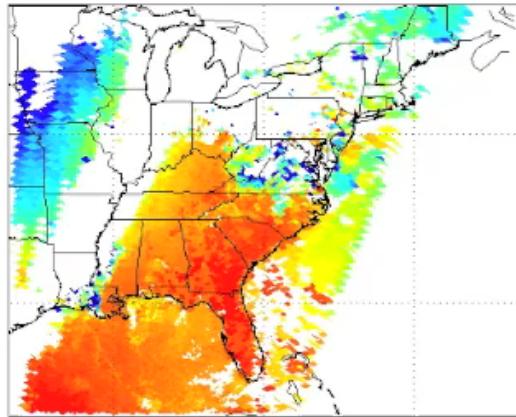
# ***Ground Remote Atmospheric Sounding Project (GRASP)***

## **Validation Campaign ( 16 – 30 April, 2012)**

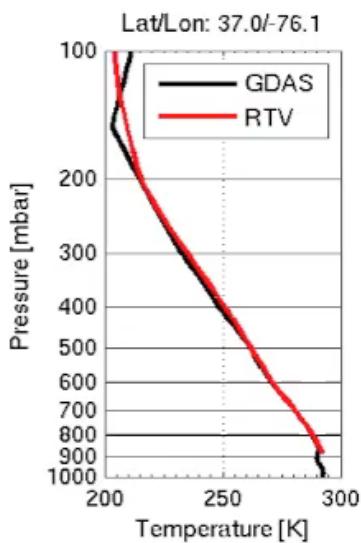
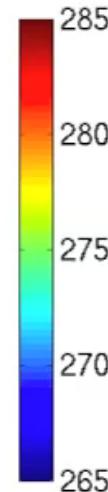
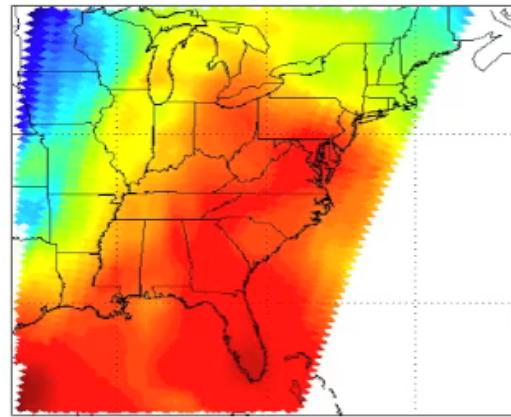
***A comprehensive data set for validating and improving satellite and ground based remote sensing measurements***

- **Satellite** sounding data was collected and processed for all Metop, Aqua, and Suomi NPP orbits within view of Hampton University (HU)
- **Radiosondes** were launched from HU at satellite overpass times
- Quasi continuous **upward looking FTS** measurements were made for determining PBL temperature, moisture, and trace gas structure
- **Raman LIDAR** measurements were made for deriving cloud, aerosol, and free troposphere temperature and water vapor profiles
- Continuous measurements of **surface meteorological and radiative flux parameters** ( $P$ ,  $T$ ,  $Q$ ,  $V$ , LW Flux, SW Flux) were obtained
- **All-sky camera** operated for identifying cloudiness during radiation and meteorological measurements

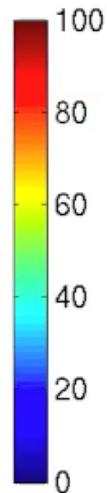
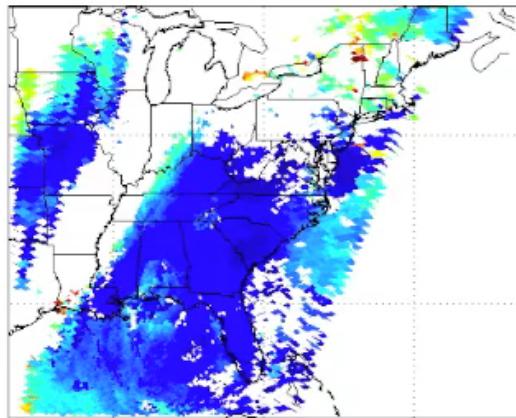
CRIS Temperature [K] at 707 hPa  
2012-04-16 (07:22,07:30)



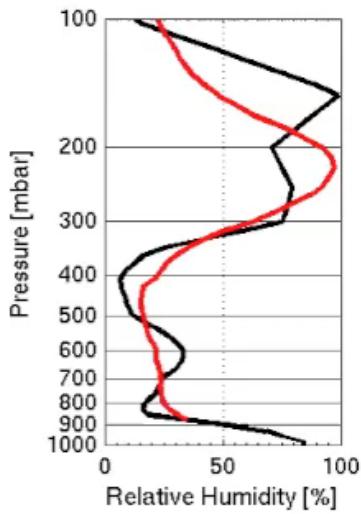
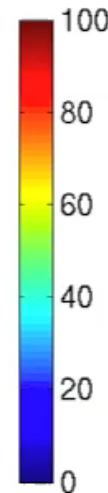
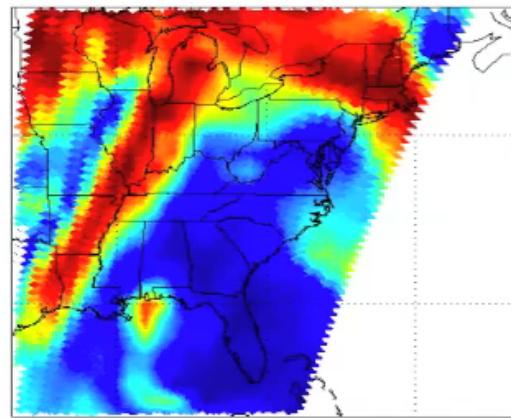
GDAS Temperature [K] at 706.6 hPa  
2012-04-16 (07:22,07:30)



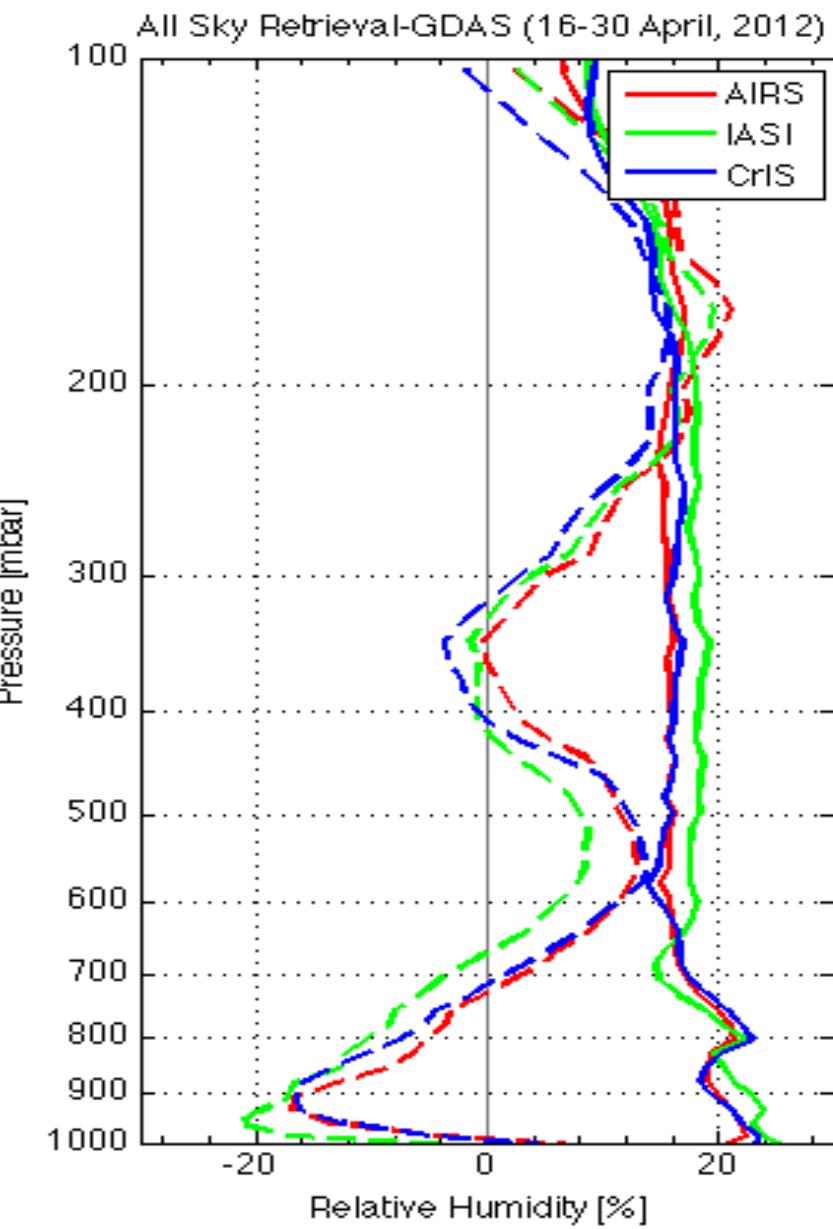
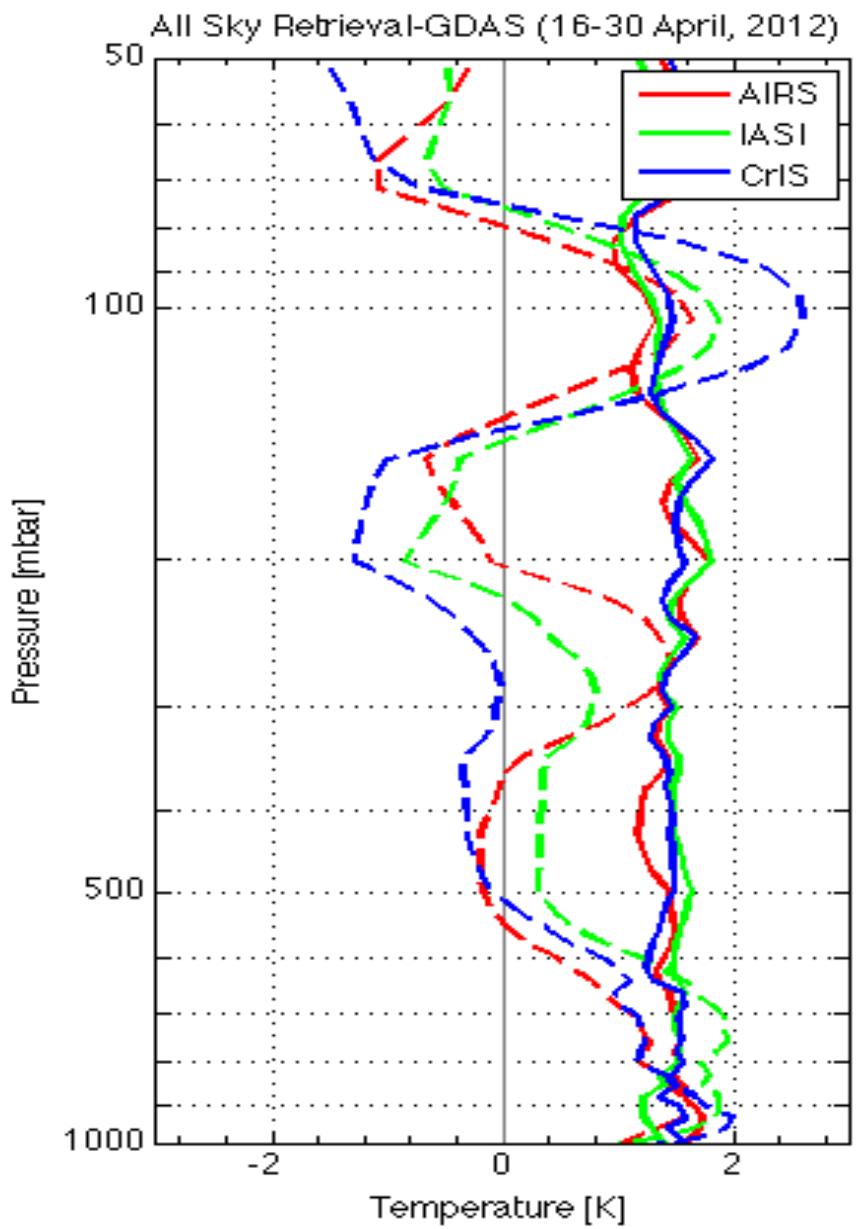
CRIS Relative Humidity [%] at 707 hPa  
2012-04-16 (07:22,07:30)



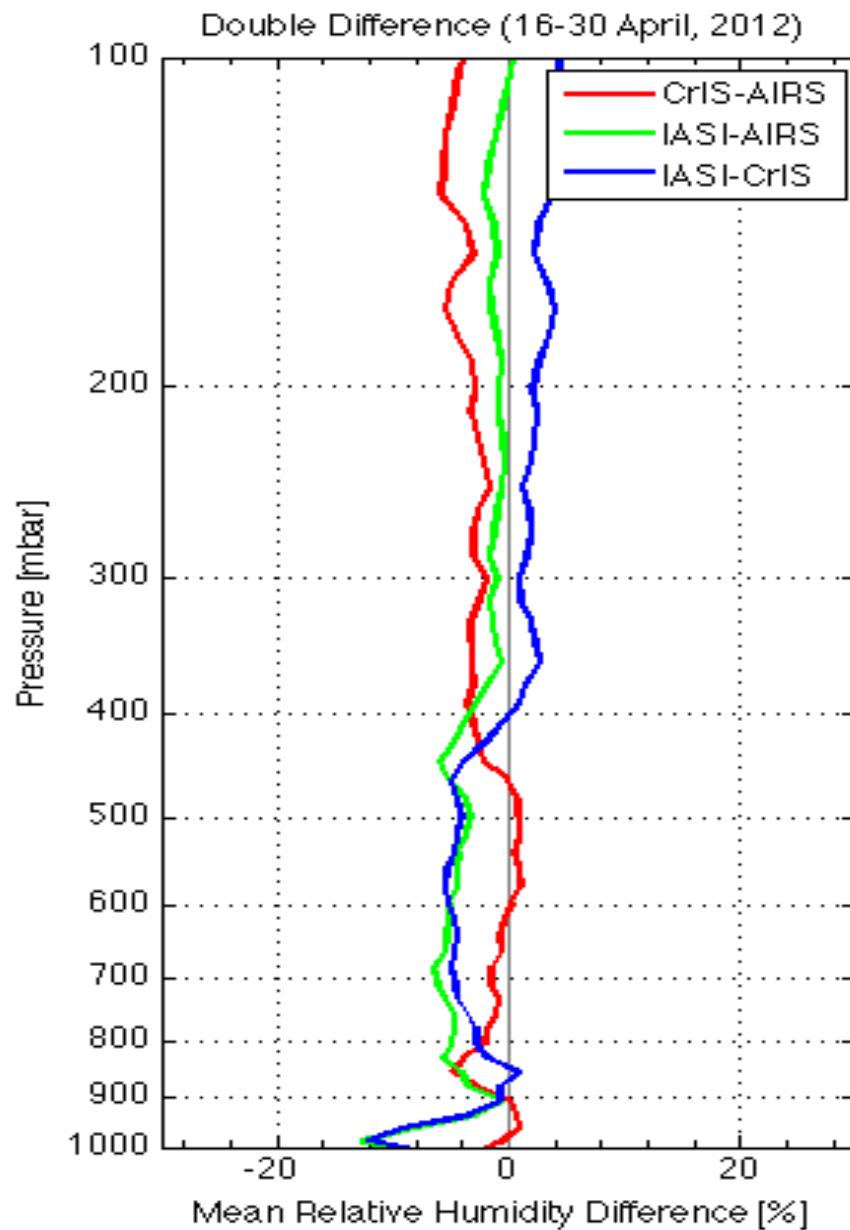
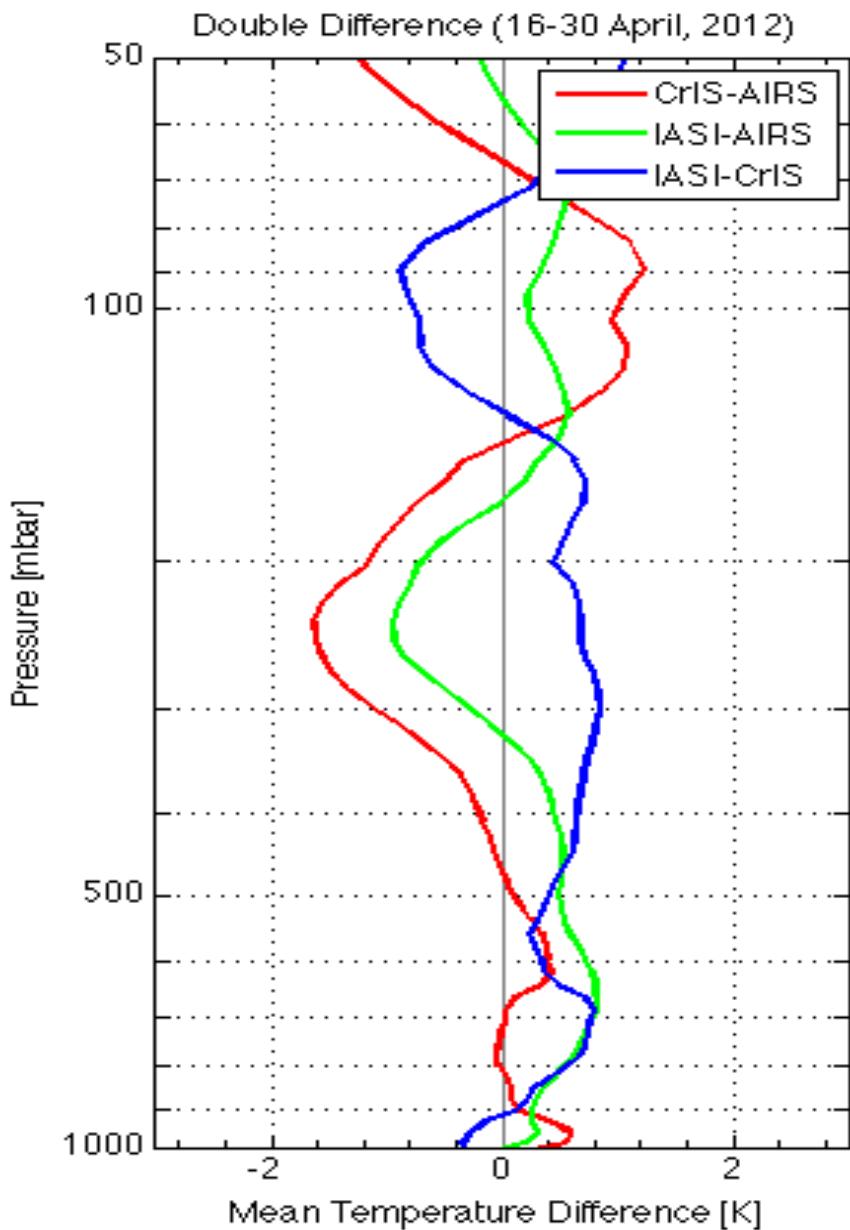
GDAS Relative Humidity [%] at 707 hPa  
2012-04-16 (07:22,07:30)



# ***GRASP Statistics (25-60N; 60-100W)***



# GRASP (Mean Double Difference)

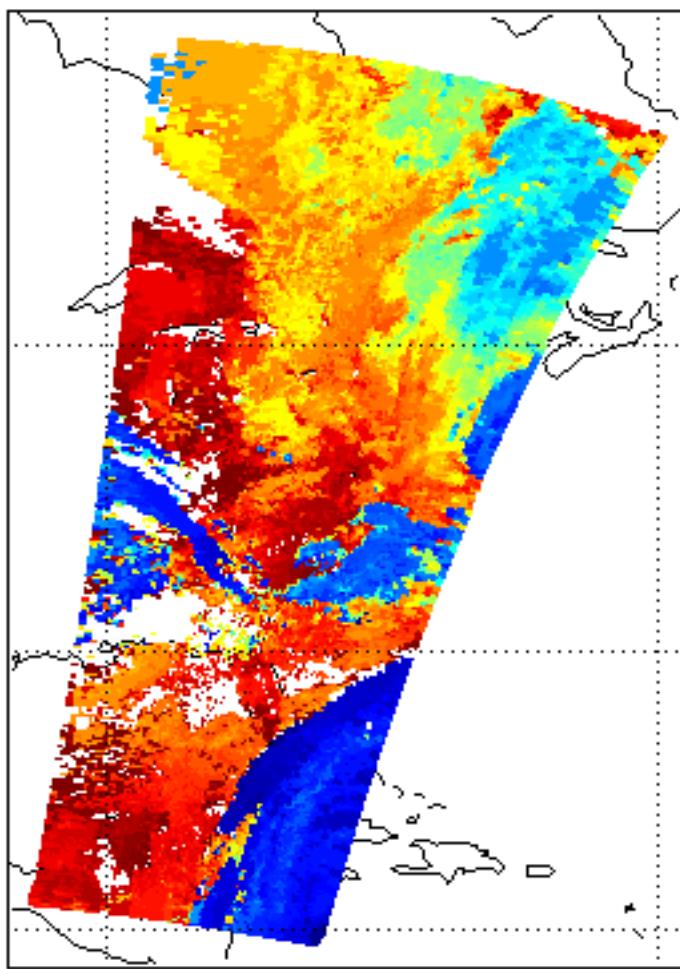


# *Aqua and Suomi NPP orbits, Eastern NA April 27, 2012*

## AIRS granules

Start times: 07:17 UTC  
AIRS granule size: 90x270  
(24300 FOVs)

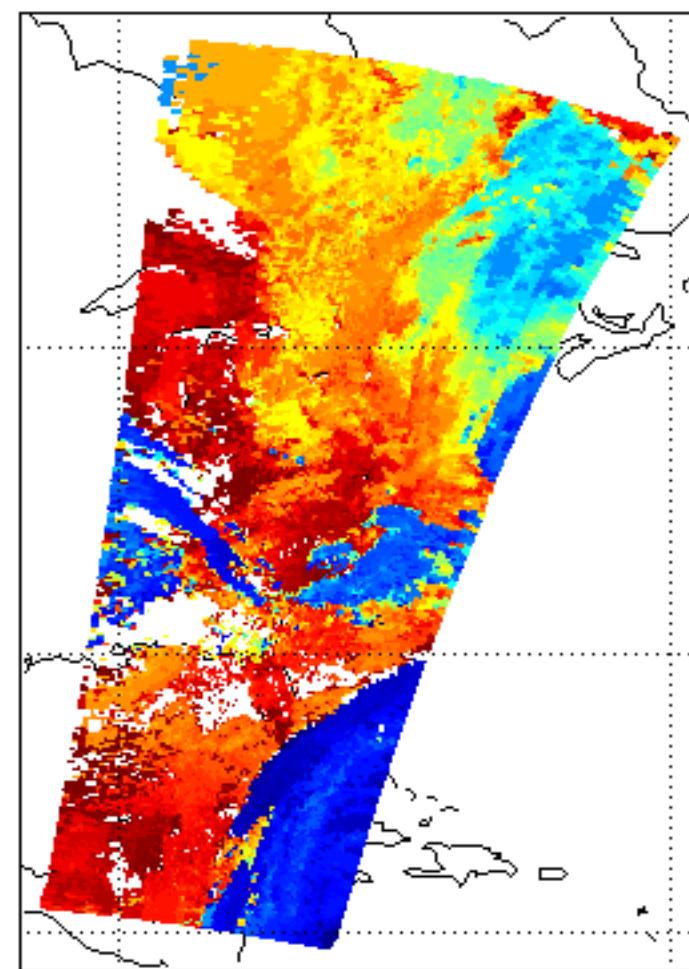
T Cloud top pressure [mbar]



## CrIS granules

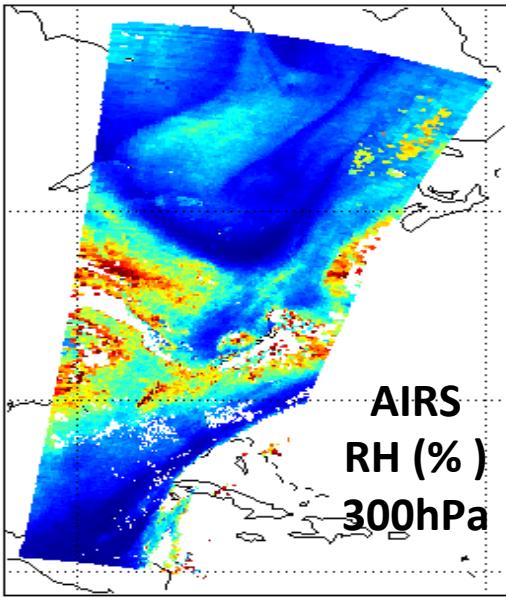
start times: 07:12 UTC  
CrIS granule size: 90x270  
(24300 FOVs)

T Cloud top pressure [mbar]

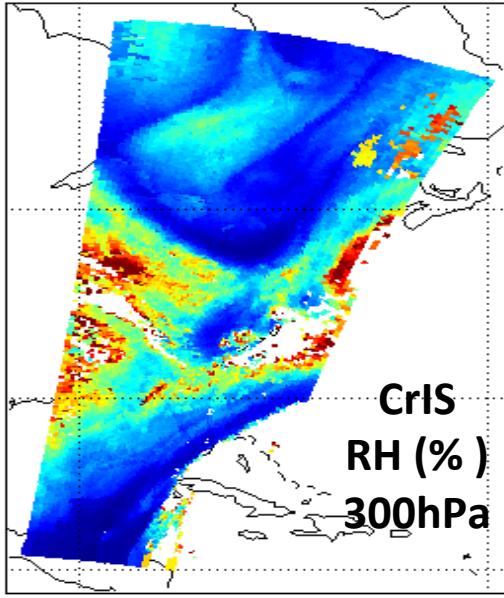


## AIRS & CrIS Retrievals (April 27, 2012)

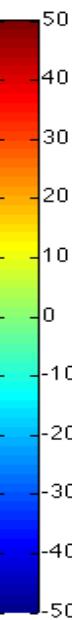
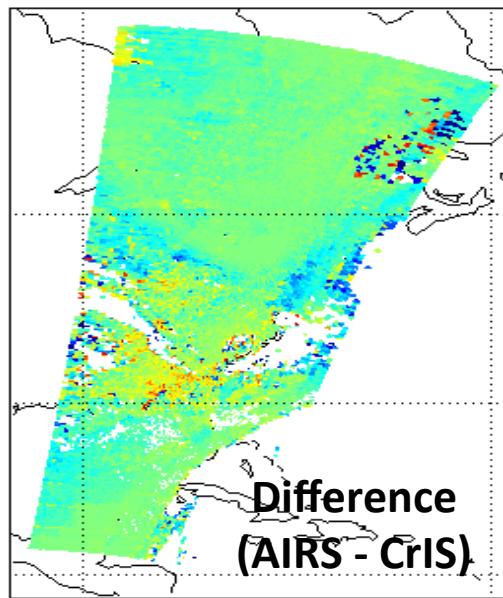
Relative Humidity [percent] at 300 mbar



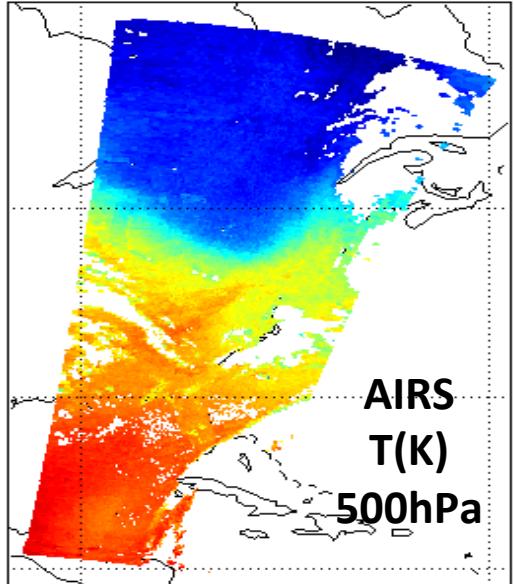
Relative Humidity [percent] at 300 mbar



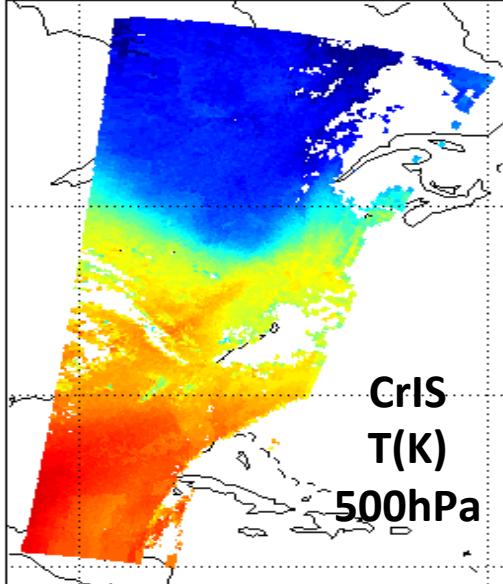
RH Change [percent] at 300 mbar



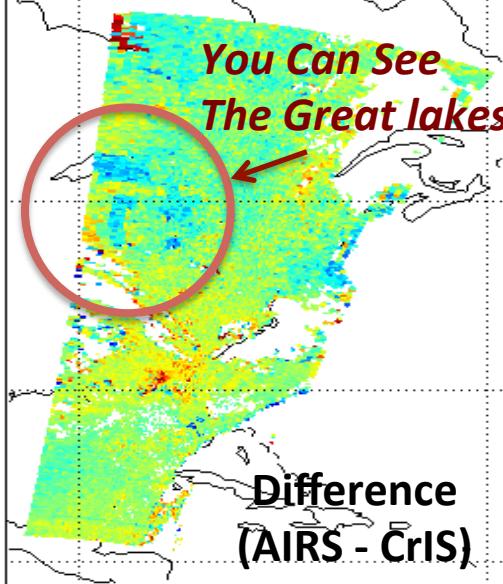
Temperature [K] at 496.63 mbar



Temperature [K] at 496.63 mbar



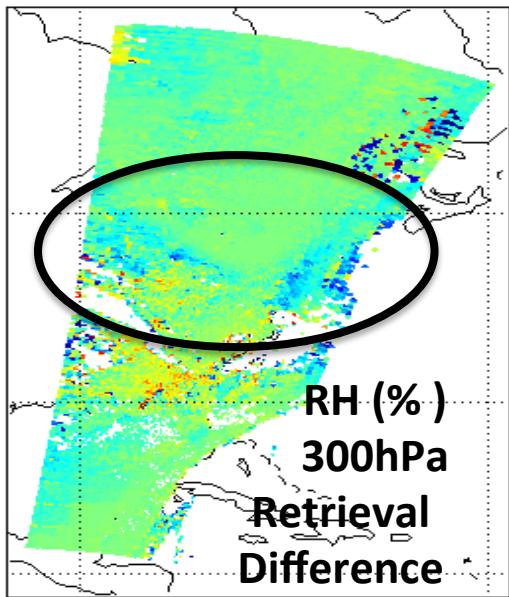
Temp Change [K] at 496.63 mbar



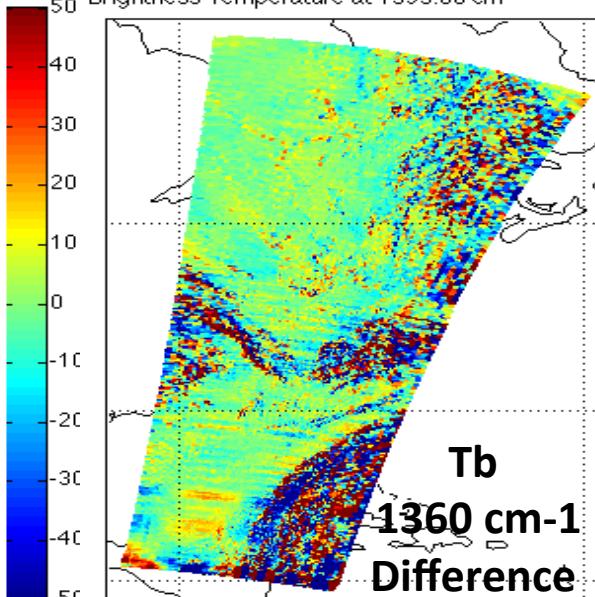
You Can See  
The Great Lakes

## ***Retrieval Reflections of 20 cm<sup>-1</sup> Mean Radiance Differences (April 27, 2012)***

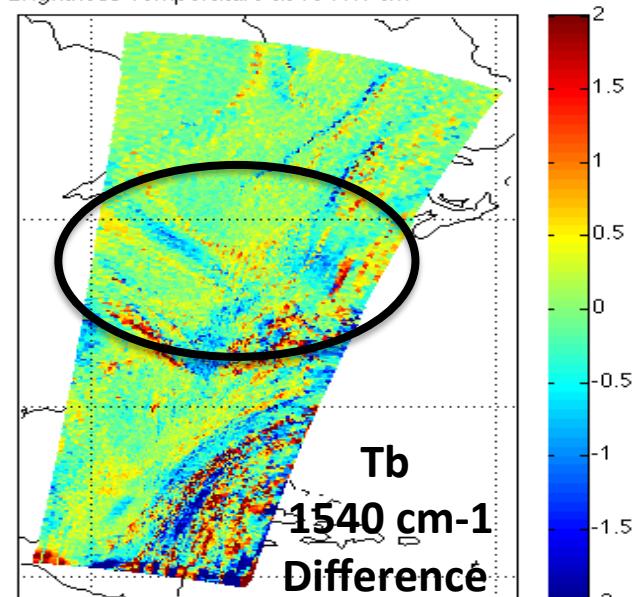
RH Change [percent] at 300 mbar



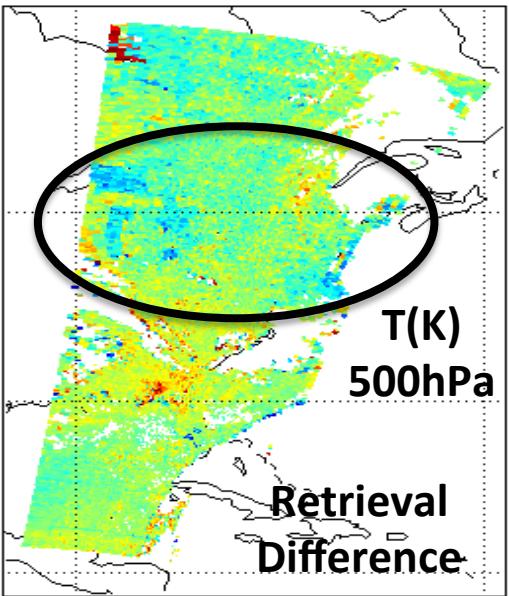
Brightness Temperature at 1359.86 cm<sup>-1</sup>



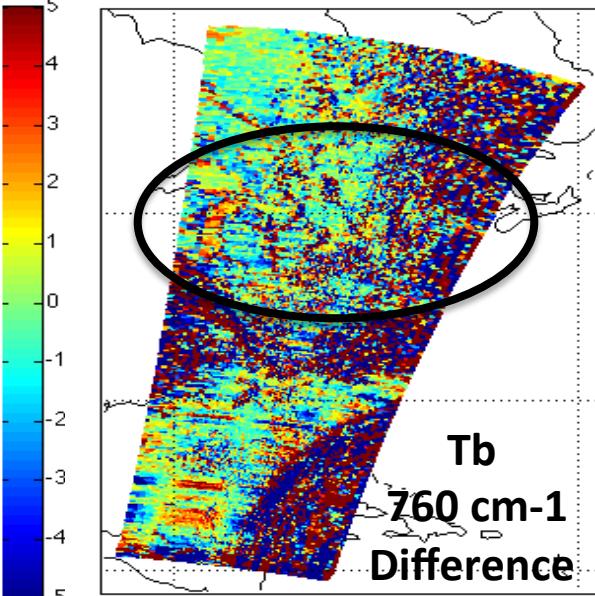
Brightness Temperature at 1541.1 cm<sup>-1</sup>



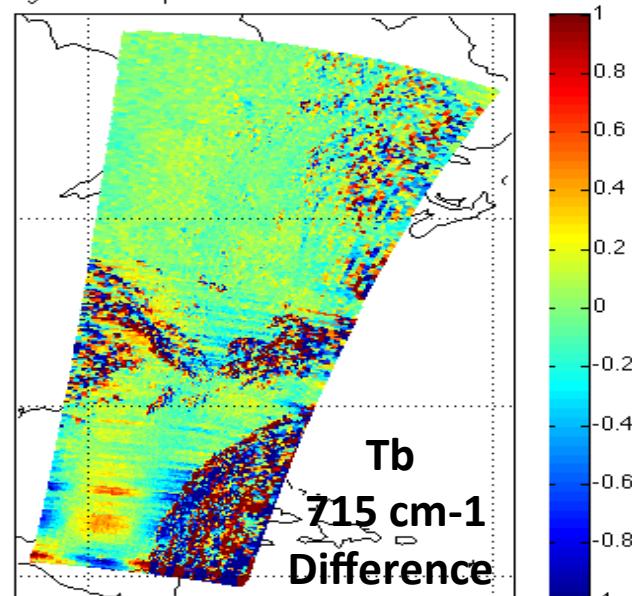
Temp Change [K] at 496.63 mbar



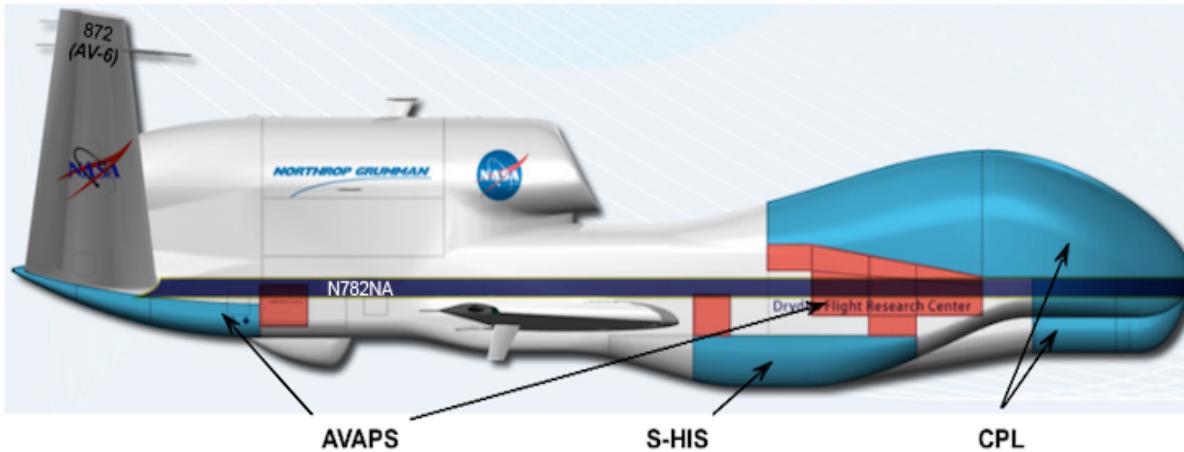
Brightness Temperature at 759.902 cm<sup>-1</sup>



Brightness Temperature at 715.065 cm<sup>-1</sup>



# The Hurricane and Severe Storm Sentinel (HS3) Mission



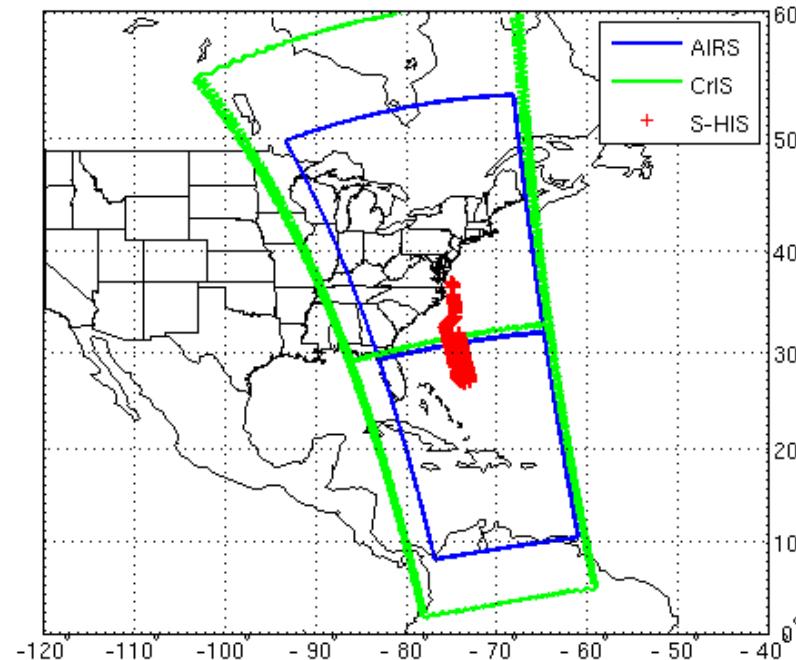
Endurance	> 30 hours
Range	>10,000 nmi
Service Ceiling	65,000 ft
Airspeed (55K+ ft)	335 KTAS
Payload	1,000-1,500 lb
Take-off Weight	26,750 lb
Length	44 ft
Wingspan	116 ft

- The GH is a fully autonomous aircraft
- The GH communicates with the ground via both satellite and direct line-of-sight links
- The GH flight mission is monitored and controlled using a ground station that is staffed by pilots and a mission director
- The GH instruments are remotely operated by scientists and a payload manager



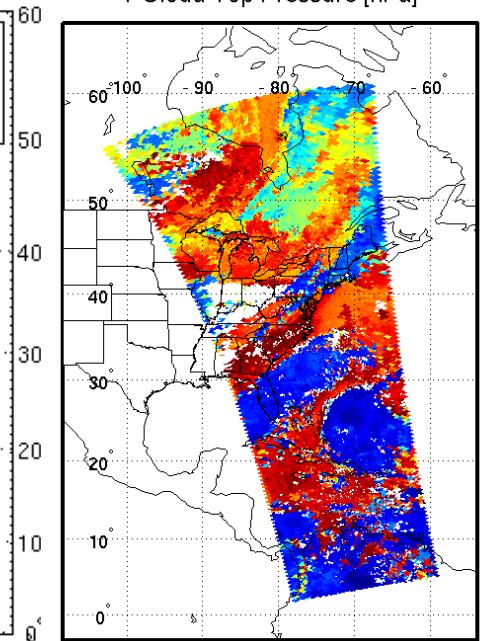
# *Suomi NPP Cal/Val Flight (Oct. 6 2012)*

06-Oct-2012



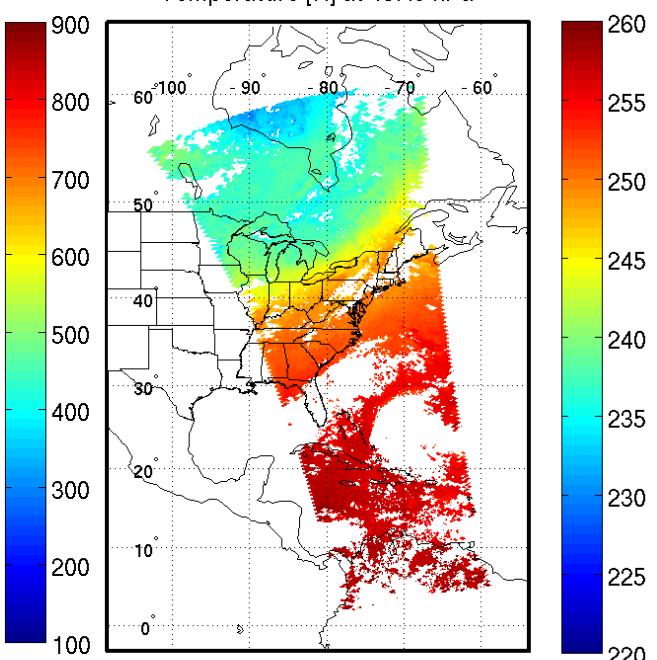
CRIS 2012-10-06

T Cloud Top Pressure [hPa]



CRIS 2012-10-06

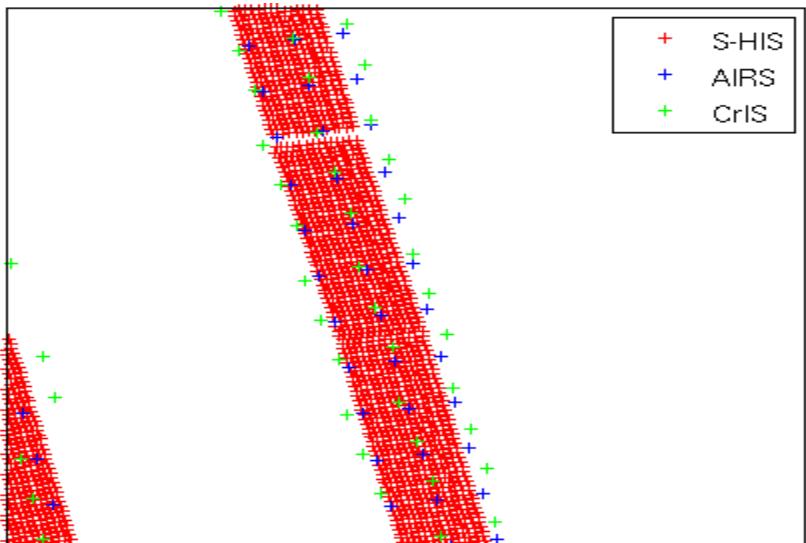
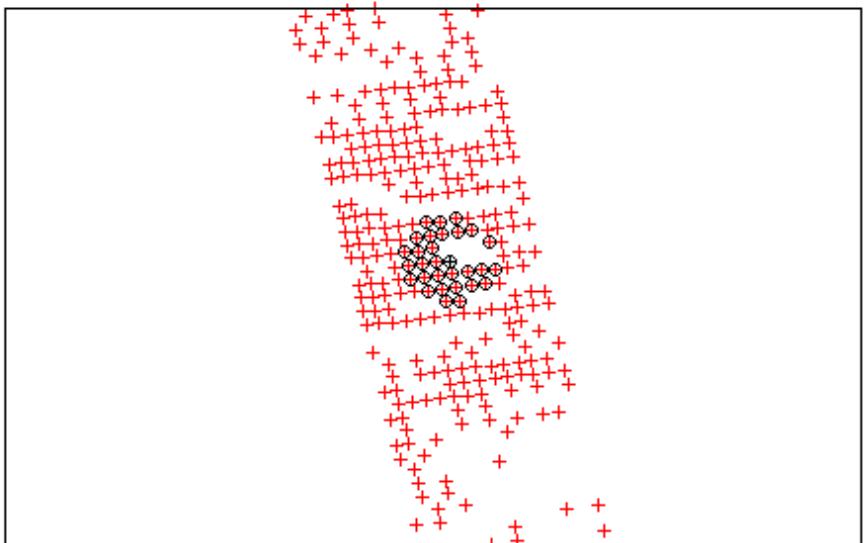
Temperature [K] at 407.5 hPa



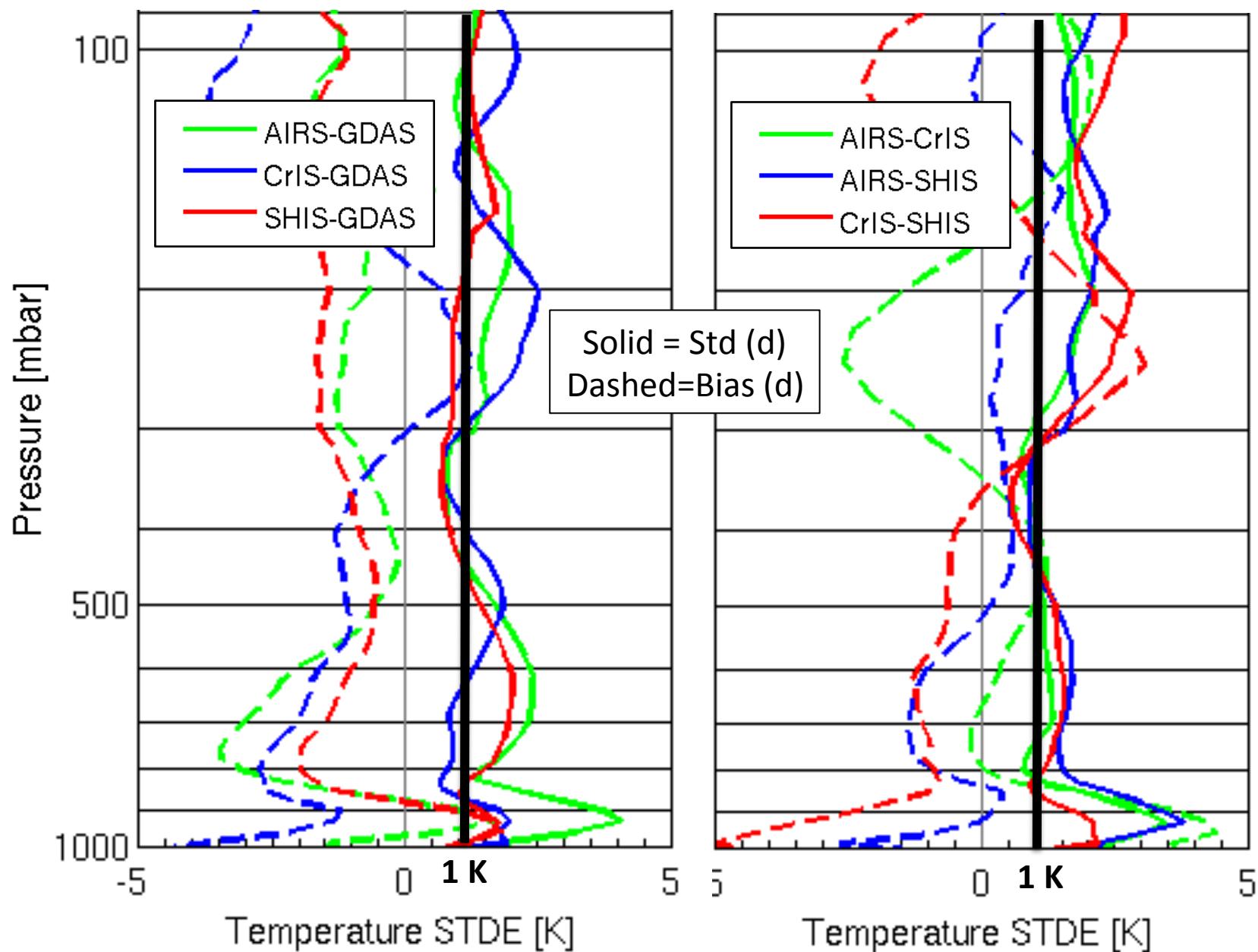
+ S-HIS

+ AIRS

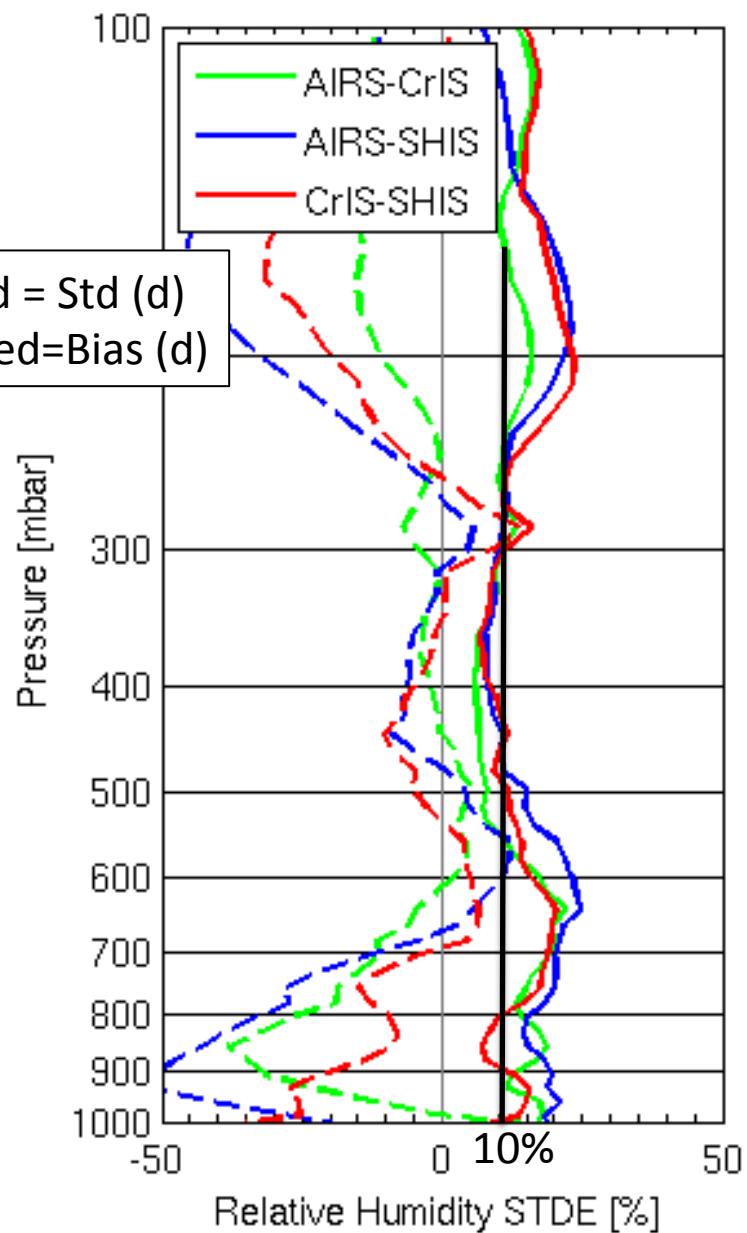
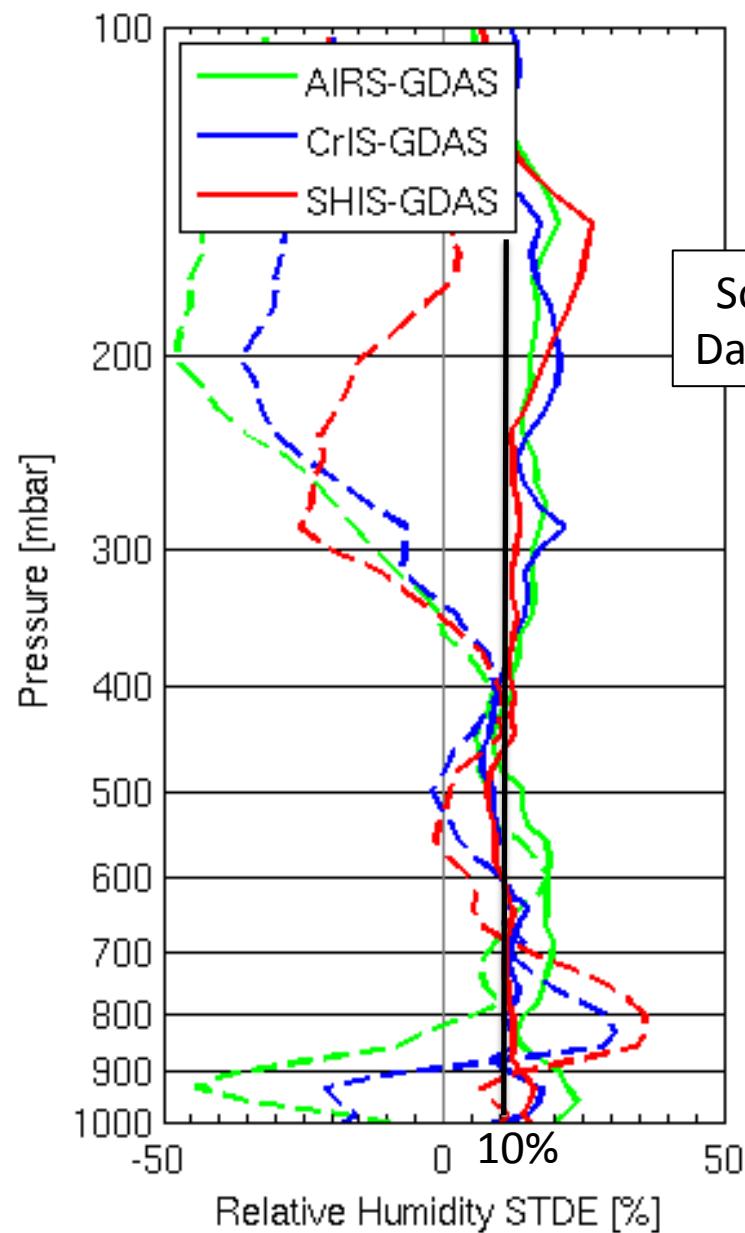
+ CrIS



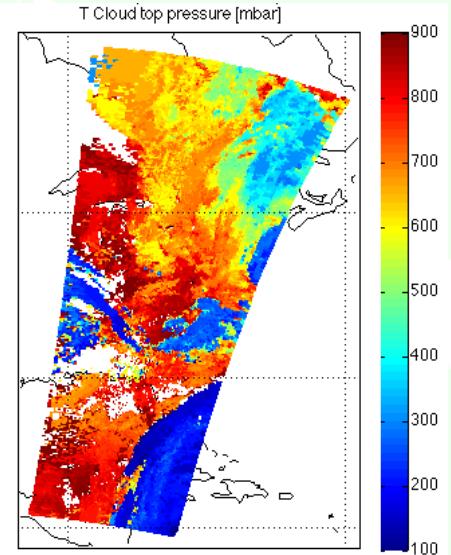
# *Suomi NPP Cal/Val Flight (Oct. 6 2012)*



# *Suomi NPP Cal/Val Flight (Oct. 6 2012)*



# Summary



## ◆ Sounding Accuracies

- Accuracies better than
  - 2 K & 20 % Absolute (Relative to GDAS)
  - 0.5 K & 5 % Relative (Instrument Differences)

## ◆ Synoptic Scale Retrieval Bias

- *Synoptic scale patterns of AIRS/CrIS retrieval differences result from small synoptic scale differences in radiance observations.*
- *Although relatively small, could be significant for the detection of small scale time tendencies for convective weather forecasting or water vapor wind determination from consecutive AIRS and NPP sounding data.*
- *Given the magnitude of ultraspectral sounders in orbit today (AIRS, CrIS, IASI-A, IASI-B), these biases can be eliminated through cross calibration of the various sensor retrievals*
- *The next step is to eliminate synoptic scale bias differences in the radiance and retrieval data so to be able to detect time tendencies of atmospheric stability and water vapor motion wind profiles from consecutive AIRS and CrIS and IASI-A and IASI-B thermodynamic retrievals*